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Supplement of

Preindustrial nitrous oxide emissions from the land biosphere estimated by using a global biogeochemistry model

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Table S1. The description of field measurements from natural vegetation in different sites.

| Number | PFT | location | | Year | References |
|--------|----------------------|-------------|----------|-----------|--------------------------------|
| | | Longitude | Latitude | | |
| 1 | Forest: Spruce | 11°25'E | 48°46'N | 1993-1995 | Butterbach-Bahl et al., 1998 |
| 2 | Forest: Spruce | 09°34'E | 51°46'N | 2007-2008 | Eickenscheidt and Brumme, 2012 |
| 3 | Forest: Liana canopy | 55°31'W | 3°59'S | 1998-2000 | Davidson et al., 2004 |
| 4 | Forest: Douglas-fir | 124°30'W | 44°00'N | 2007-2008 | Erickson and Perakis, 2014 |
| 5 | Grassland | 09°42'E | 51°46'N | 2008-2009 | Hoefl et al., 2012 |
| 6 | Forest | 156°14'W | 20°48'N | 2000-2001 | Holtgrieve et al., 2006 |
| 7 | Forest: Spruce & Oak | 19°57'–58'E | 47°53'N | 2002-2003 | Horváth et al., 2006 |
| 8 | Forest: Beech | 16°15'E | 48°14'N | 2002-2004 | Kitzler et al., 2006 |
| 9 | Grassland | 104°42'W | 40°50'N | 1997-2000 | Mosier et al., 2002 |
| 10 | Tropical rainforest | 145°30'E | 17°30'S | 1997-1999 | Breuer et al., 2000 |
| 11 | Tropical rainforest | 63°00'W | 10°00'S | – | Stehfest and Bouwman, 2006 |
| 12 | Savanna | 28°30'E | 24°30'S | 1994 | Scholes et al., 1997 |
| 13 | Tropical forest | 47°30'W | 3°00'S | 1987 | Luizão et al., 1989 |
| 14 | Tropical forest | 115°30'E | 2°00'S | 1998-1999 | Hadi et al., 2000 |
| 15 | Tropical forest | 84°00'W | 10°26'N | 1990-1991 | Keller and Reiners, 1994 |
| 16 | Subtropical forest | 66°00'W | 18°00'N | 1995-1996 | Erickson et al. 2001 |
| 17 | Temperate forest | 116°30'E | 39°30'N | 1997-1998 | Sun and Xu, 2001 |
| 18 | Temperate forest | 89°00'W | 43°00'N | 1979-1981 | Goodroad and Keeney, 1984 |
| 19 | Grassland | 116°04'E | 43°26'N | 1995 | Chen et al., 2000 |
| 20 | Temperate forest | 126°55'E | 41°23'N | 1994-1995 | |

Table S2. All results of the global-, continental-, and biome-level N₂O emission from 100 sets of DLEM simulations in 1860. The unit is Tg N yr⁻¹.

| No. | Total | Europe | North America | South America | Southern Asia | Northern Asia | Oceania | Africa | Boreal Forest | Tropical Forest | Temperate Forest | Shrubland | Grassland | Cropland | Tundra |
|-----|-------|--------|---------------|---------------|---------------|---------------|---------|--------|---------------|-----------------|------------------|-----------|-----------|----------|--------|
| 1 | 6.986 | 0.339 | 0.774 | 2.323 | 1.315 | 0.175 | 0.348 | 1.645 | 0.695 | 4.467 | 0.695 | 0.925 | 0.225 | 0.479 | 0.010 |
| 2 | 6.546 | 0.292 | 0.684 | 2.244 | 1.225 | 0.166 | 0.325 | 1.545 | 0.594 | 4.281 | 0.594 | 0.845 | 0.199 | 0.428 | 0.013 |
| 3 | 5.121 | 0.243 | 0.554 | 1.724 | 0.959 | 0.124 | 0.254 | 1.213 | 0.504 | 3.309 | 0.504 | 0.672 | 0.159 | 0.341 | 0.005 |
| 4 | 6.699 | 0.350 | 0.772 | 2.167 | 1.248 | 0.179 | 0.339 | 1.578 | 0.734 | 4.180 | 0.734 | 0.926 | 0.219 | 0.443 | 0.012 |
| 5 | 5.386 | 0.257 | 0.585 | 1.807 | 1.004 | 0.137 | 0.268 | 1.275 | 0.536 | 3.466 | 0.536 | 0.715 | 0.165 | 0.347 | 0.009 |
| 6 | 6.178 | 0.317 | 0.701 | 2.016 | 1.152 | 0.163 | 0.312 | 1.458 | 0.661 | 3.882 | 0.661 | 0.846 | 0.199 | 0.408 | 0.011 |
| 7 | 6.029 | 0.268 | 0.627 | 2.073 | 1.129 | 0.150 | 0.298 | 1.424 | 0.545 | 3.953 | 0.545 | 0.775 | 0.182 | 0.396 | 0.010 |
| 8 | 6.966 | 0.303 | 0.720 | 2.405 | 1.306 | 0.176 | 0.346 | 1.643 | 0.612 | 4.583 | 0.612 | 0.892 | 0.211 | 0.455 | 0.014 |
| 9 | 6.033 | 0.289 | 0.659 | 2.019 | 1.132 | 0.150 | 0.300 | 1.426 | 0.595 | 3.878 | 0.595 | 0.796 | 0.190 | 0.406 | 0.008 |
| 10 | 5.666 | 0.259 | 0.602 | 1.932 | 1.067 | 0.134 | 0.278 | 1.338 | 0.530 | 3.703 | 0.530 | 0.728 | 0.175 | 0.381 | 0.005 |
| 11 | 5.796 | 0.267 | 0.616 | 1.970 | 1.088 | 0.142 | 0.287 | 1.369 | 0.545 | 3.770 | 0.545 | 0.751 | 0.179 | 0.389 | 0.008 |
| 12 | 4.945 | 0.218 | 0.508 | 1.713 | 0.929 | 0.117 | 0.244 | 1.167 | 0.442 | 3.258 | 0.442 | 0.628 | 0.149 | 0.333 | 0.006 |
| 13 | 7.677 | 0.376 | 0.855 | 2.536 | 1.437 | 0.205 | 0.386 | 1.806 | 0.773 | 4.873 | 0.773 | 1.033 | 0.246 | 0.511 | 0.017 |
| 14 | 5.347 | 0.236 | 0.551 | 1.851 | 1.003 | 0.129 | 0.264 | 1.263 | 0.478 | 3.523 | 0.478 | 0.681 | 0.161 | 0.355 | 0.007 |
| 15 | 6.257 | 0.321 | 0.709 | 2.041 | 1.167 | 0.168 | 0.317 | 1.474 | 0.667 | 3.924 | 0.667 | 0.859 | 0.201 | 0.416 | 0.013 |
| 16 | 7.443 | 0.335 | 0.787 | 2.540 | 1.414 | 0.181 | 0.371 | 1.742 | 0.666 | 4.847 | 0.666 | 0.955 | 0.237 | 0.528 | 0.011 |
| 17 | 6.384 | 0.287 | 0.670 | 2.184 | 1.188 | 0.167 | 0.318 | 1.509 | 0.590 | 4.164 | 0.590 | 0.833 | 0.192 | 0.404 | 0.014 |
| 18 | 6.019 | 0.303 | 0.675 | 1.979 | 1.123 | 0.158 | 0.303 | 1.421 | 0.629 | 3.803 | 0.629 | 0.818 | 0.192 | 0.400 | 0.011 |
| 19 | 5.520 | 0.251 | 0.587 | 1.886 | 1.042 | 0.127 | 0.269 | 1.304 | 0.514 | 3.615 | 0.514 | 0.706 | 0.171 | 0.376 | 0.003 |
| 20 | 6.455 | 0.291 | 0.673 | 2.205 | 1.206 | 0.170 | 0.324 | 1.523 | 0.589 | 4.197 | 0.589 | 0.842 | 0.196 | 0.422 | 0.016 |
| 21 | 6.145 | 0.253 | 0.580 | 2.090 | 1.170 | 0.128 | 0.278 | 1.583 | 0.480 | 4.105 | 0.480 | 0.805 | 0.185 | 0.443 | 0.015 |
| 22 | 6.886 | 0.343 | 0.770 | 2.266 | 1.287 | 0.183 | 0.347 | 1.623 | 0.708 | 4.354 | 0.708 | 0.933 | 0.221 | 0.459 | 0.014 |
| 23 | 6.927 | 0.300 | 0.714 | 2.395 | 1.313 | 0.166 | 0.344 | 1.627 | 0.596 | 4.563 | 0.596 | 0.876 | 0.214 | 0.480 | 0.010 |
| 24 | 7.927 | 0.381 | 0.866 | 2.635 | 1.482 | 0.221 | 0.403 | 1.862 | 0.774 | 5.038 | 0.774 | 1.067 | 0.251 | 0.524 | 0.024 |
| 25 | 8.045 | 0.388 | 0.885 | 2.669 | 1.501 | 0.224 | 0.407 | 1.892 | 0.795 | 5.117 | 0.795 | 1.085 | 0.253 | 0.521 | 0.023 |
| 26 | 4.766 | 0.219 | 0.507 | 1.627 | 0.898 | 0.108 | 0.233 | 1.129 | 0.451 | 3.120 | 0.451 | 0.610 | 0.147 | 0.323 | 0.002 |
| 27 | 5.459 | 0.253 | 0.578 | 1.856 | 1.025 | 0.134 | 0.271 | 1.288 | 0.514 | 3.547 | 0.514 | 0.708 | 0.168 | 0.369 | 0.007 |
| 28 | 5.181 | 0.252 | 0.567 | 1.730 | 0.964 | 0.134 | 0.260 | 1.226 | 0.526 | 3.314 | 0.526 | 0.696 | 0.160 | 0.334 | 0.008 |

| No. | Total | Europe | North America | South America | Southern Asia | Northern Asia | Oceania | Africa | Boreal Forest | Tropical Forest | Temperate Forest | Shrubland | Grassland | Cropland | Tundra |
|-----|-------|--------|---------------|---------------|---------------|---------------|---------|--------|---------------|-----------------|------------------|-----------|-----------|----------|--------|
| 29 | 6.774 | 0.314 | 0.724 | 2.290 | 1.267 | 0.176 | 0.339 | 1.597 | 0.642 | 4.373 | 0.642 | 0.891 | 0.210 | 0.447 | 0.015 |
| 30 | 6.805 | 0.325 | 0.741 | 2.275 | 1.268 | 0.184 | 0.341 | 1.605 | 0.671 | 4.357 | 0.671 | 0.911 | 0.211 | 0.436 | 0.016 |
| 31 | 6.258 | 0.260 | 0.603 | 2.121 | 1.204 | 0.125 | 0.282 | 1.598 | 0.494 | 4.168 | 0.494 | 0.822 | 0.191 | 0.465 | 0.012 |
| 32 | 7.660 | 0.370 | 0.839 | 2.543 | 1.438 | 0.205 | 0.388 | 1.802 | 0.749 | 4.877 | 0.749 | 1.024 | 0.245 | 0.517 | 0.019 |
| 33 | 6.276 | 0.319 | 0.711 | 2.054 | 1.167 | 0.167 | 0.316 | 1.481 | 0.670 | 3.955 | 0.670 | 0.860 | 0.199 | 0.404 | 0.012 |
| 34 | 6.591 | 0.294 | 0.691 | 2.261 | 1.242 | 0.160 | 0.326 | 1.551 | 0.595 | 4.315 | 0.595 | 0.845 | 0.204 | 0.447 | 0.010 |
| 35 | 5.087 | 0.224 | 0.525 | 1.763 | 0.963 | 0.115 | 0.249 | 1.198 | 0.451 | 3.360 | 0.451 | 0.639 | 0.156 | 0.354 | 0.003 |
| 36 | 8.133 | 0.381 | 0.878 | 2.728 | 1.521 | 0.222 | 0.411 | 1.911 | 0.772 | 5.213 | 0.772 | 1.081 | 0.255 | 0.536 | 0.024 |
| 37 | 6.066 | 0.293 | 0.665 | 2.026 | 1.144 | 0.147 | 0.301 | 1.431 | 0.597 | 3.895 | 0.597 | 0.796 | 0.194 | 0.421 | 0.007 |
| 38 | 4.979 | 0.243 | 0.545 | 1.660 | 0.930 | 0.125 | 0.249 | 1.178 | 0.505 | 3.185 | 0.505 | 0.664 | 0.155 | 0.331 | 0.007 |
| 39 | 5.230 | 0.249 | 0.569 | 1.760 | 0.980 | 0.124 | 0.257 | 1.240 | 0.519 | 3.386 | 0.519 | 0.685 | 0.163 | 0.345 | 0.004 |
| 40 | 6.075 | 0.275 | 0.641 | 2.076 | 1.135 | 0.153 | 0.301 | 1.435 | 0.566 | 3.964 | 0.566 | 0.788 | 0.185 | 0.394 | 0.010 |
| 41 | 6.822 | 0.266 | 0.681 | 2.228 | 1.223 | 0.264 | 0.519 | 1.577 | 0.550 | 4.225 | 0.550 | 1.074 | 0.233 | 0.440 | 0.050 |
| 42 | 5.872 | 0.242 | 0.582 | 2.075 | 1.113 | 0.135 | 0.288 | 1.380 | 0.477 | 3.931 | 0.477 | 0.724 | 0.176 | 0.407 | 0.006 |
| 43 | 6.743 | 0.298 | 0.702 | 2.317 | 1.261 | 0.172 | 0.335 | 1.592 | 0.607 | 4.416 | 0.607 | 0.870 | 0.204 | 0.438 | 0.014 |
| 44 | 7.161 | 0.380 | 0.832 | 2.300 | 1.338 | 0.195 | 0.365 | 1.682 | 0.788 | 4.435 | 0.788 | 0.996 | 0.237 | 0.483 | 0.016 |
| 45 | 5.090 | 0.224 | 0.525 | 1.764 | 0.954 | 0.121 | 0.250 | 1.203 | 0.457 | 3.358 | 0.457 | 0.647 | 0.153 | 0.337 | 0.006 |
| 46 | 5.912 | 0.253 | 0.596 | 2.061 | 1.108 | 0.147 | 0.294 | 1.395 | 0.506 | 3.908 | 0.506 | 0.749 | 0.176 | 0.393 | 0.011 |
| 47 | 6.370 | 0.332 | 0.731 | 2.066 | 1.191 | 0.165 | 0.321 | 1.502 | 0.692 | 3.987 | 0.692 | 0.873 | 0.209 | 0.428 | 0.010 |
| 48 | 5.153 | 0.214 | 0.513 | 1.821 | 0.967 | 0.120 | 0.252 | 1.216 | 0.432 | 3.452 | 0.432 | 0.640 | 0.151 | 0.339 | 0.006 |
| 49 | 6.057 | 0.290 | 0.665 | 2.030 | 1.138 | 0.146 | 0.298 | 1.431 | 0.600 | 3.906 | 0.600 | 0.795 | 0.192 | 0.407 | 0.006 |
| 50 | 4.905 | 0.217 | 0.507 | 1.699 | 0.922 | 0.114 | 0.241 | 1.158 | 0.441 | 3.236 | 0.441 | 0.621 | 0.148 | 0.331 | 0.004 |
| 51 | 4.862 | 0.227 | 0.521 | 1.650 | 0.912 | 0.115 | 0.239 | 1.153 | 0.470 | 3.165 | 0.470 | 0.631 | 0.149 | 0.322 | 0.004 |
| 52 | 7.706 | 0.355 | 0.825 | 2.603 | 1.441 | 0.206 | 0.387 | 1.814 | 0.724 | 4.972 | 0.724 | 1.016 | 0.239 | 0.504 | 0.020 |
| 53 | 6.758 | 0.306 | 0.708 | 2.304 | 1.266 | 0.176 | 0.339 | 1.593 | 0.617 | 4.390 | 0.617 | 0.881 | 0.207 | 0.448 | 0.016 |
| 54 | 5.321 | 0.248 | 0.565 | 1.806 | 0.993 | 0.136 | 0.266 | 1.255 | 0.508 | 3.443 | 0.508 | 0.699 | 0.162 | 0.349 | 0.009 |
| 55 | 5.758 | 0.281 | 0.635 | 1.914 | 1.076 | 0.146 | 0.288 | 1.362 | 0.584 | 3.678 | 0.584 | 0.769 | 0.181 | 0.382 | 0.008 |
| 56 | 5.814 | 0.247 | 0.586 | 2.033 | 1.078 | 0.150 | 0.288 | 1.375 | 0.503 | 3.850 | 0.503 | 0.742 | 0.169 | 0.362 | 0.014 |

| No. | Total | Europe | North America | South America | Southern Asia | Northern Asia | Oceania | Africa | Boreal Forest | Tropical Forest | Temperate Forest | Shrubland | Grassland | Cropland | Tundra |
|-----|-------|--------|---------------|---------------|---------------|---------------|---------|--------|---------------|-----------------|------------------|-----------|-----------|----------|--------|
| 57 | 7.764 | 0.400 | 0.887 | 2.516 | 1.452 | 0.215 | 0.396 | 1.822 | 0.823 | 4.840 | 0.823 | 1.070 | 0.254 | 0.523 | 0.020 |
| 58 | 5.386 | 0.230 | 0.545 | 1.884 | 1.019 | 0.124 | 0.265 | 1.268 | 0.459 | 3.581 | 0.459 | 0.672 | 0.162 | 0.370 | 0.005 |
| 59 | 5.222 | 0.232 | 0.543 | 1.801 | 0.970 | 0.131 | 0.259 | 1.236 | 0.482 | 3.427 | 0.482 | 0.676 | 0.154 | 0.328 | 0.009 |
| 60 | 6.341 | 0.290 | 0.667 | 2.159 | 1.182 | 0.168 | 0.318 | 1.495 | 0.589 | 4.110 | 0.589 | 0.832 | 0.192 | 0.411 | 0.016 |
| 61 | 7.150 | 0.326 | 0.761 | 2.430 | 1.354 | 0.175 | 0.356 | 1.678 | 0.653 | 4.645 | 0.653 | 0.922 | 0.227 | 0.500 | 0.011 |
| 62 | 5.007 | 0.229 | 0.531 | 1.709 | 0.947 | 0.113 | 0.245 | 1.183 | 0.469 | 3.275 | 0.469 | 0.639 | 0.156 | 0.348 | 0.002 |
| 63 | 5.877 | 0.259 | 0.610 | 2.030 | 1.112 | 0.138 | 0.289 | 1.383 | 0.521 | 3.869 | 0.521 | 0.744 | 0.181 | 0.406 | 0.006 |
| 64 | 5.175 | 0.231 | 0.539 | 1.786 | 0.976 | 0.119 | 0.254 | 1.220 | 0.468 | 3.409 | 0.468 | 0.655 | 0.158 | 0.353 | 0.004 |
| 65 | 6.739 | 0.324 | 0.740 | 2.244 | 1.255 | 0.179 | 0.338 | 1.591 | 0.674 | 4.307 | 0.674 | 0.905 | 0.210 | 0.433 | 0.014 |
| 66 | 5.383 | 0.253 | 0.577 | 1.819 | 1.006 | 0.134 | 0.268 | 1.273 | 0.521 | 3.483 | 0.521 | 0.706 | 0.165 | 0.353 | 0.008 |
| 67 | 6.911 | 0.344 | 0.772 | 2.276 | 1.296 | 0.181 | 0.347 | 1.628 | 0.705 | 4.376 | 0.705 | 0.930 | 0.223 | 0.469 | 0.013 |
| 68 | 5.503 | 0.219 | 0.536 | 1.967 | 1.031 | 0.128 | 0.268 | 1.299 | 0.440 | 3.719 | 0.440 | 0.675 | 0.158 | 0.357 | 0.007 |
| 69 | 6.429 | 0.297 | 0.684 | 2.181 | 1.201 | 0.166 | 0.321 | 1.516 | 0.606 | 4.164 | 0.606 | 0.843 | 0.197 | 0.420 | 0.013 |
| 70 | 7.045 | 0.333 | 0.766 | 2.361 | 1.326 | 0.179 | 0.351 | 1.660 | 0.678 | 4.531 | 0.678 | 0.927 | 0.223 | 0.479 | 0.012 |
| 71 | 6.688 | 0.309 | 0.720 | 2.263 | 1.268 | 0.159 | 0.330 | 1.573 | 0.626 | 4.338 | 0.626 | 0.864 | 0.214 | 0.470 | 0.007 |
| 72 | 5.739 | 0.280 | 0.633 | 1.911 | 1.077 | 0.141 | 0.285 | 1.357 | 0.579 | 3.675 | 0.579 | 0.760 | 0.183 | 0.390 | 0.006 |
| 73 | 4.956 | 0.232 | 0.529 | 1.679 | 0.925 | 0.123 | 0.247 | 1.172 | 0.480 | 3.207 | 0.480 | 0.651 | 0.152 | 0.326 | 0.007 |
| 74 | 5.216 | 0.252 | 0.566 | 1.746 | 0.974 | 0.134 | 0.261 | 1.233 | 0.519 | 3.342 | 0.519 | 0.695 | 0.161 | 0.345 | 0.009 |
| 75 | 5.450 | 0.258 | 0.592 | 1.838 | 1.031 | 0.125 | 0.267 | 1.287 | 0.529 | 3.534 | 0.529 | 0.704 | 0.173 | 0.379 | 0.002 |
| 76 | 5.734 | 0.238 | 0.570 | 2.021 | 1.069 | 0.141 | 0.282 | 1.357 | 0.481 | 3.828 | 0.481 | 0.720 | 0.167 | 0.367 | 0.010 |
| 77 | 5.783 | 0.273 | 0.621 | 1.948 | 1.086 | 0.144 | 0.289 | 1.366 | 0.557 | 3.731 | 0.557 | 0.759 | 0.180 | 0.391 | 0.009 |
| 78 | 5.469 | 0.223 | 0.541 | 1.938 | 1.027 | 0.127 | 0.267 | 1.291 | 0.450 | 3.673 | 0.450 | 0.676 | 0.160 | 0.360 | 0.007 |
| 79 | 7.412 | 0.352 | 0.802 | 2.480 | 1.387 | 0.200 | 0.374 | 1.744 | 0.714 | 4.743 | 0.714 | 0.987 | 0.233 | 0.491 | 0.020 |
| 80 | 5.884 | 0.281 | 0.641 | 1.972 | 1.107 | 0.144 | 0.292 | 1.390 | 0.576 | 3.789 | 0.576 | 0.772 | 0.186 | 0.402 | 0.007 |
| 81 | 5.102 | 0.218 | 0.519 | 1.786 | 0.961 | 0.116 | 0.249 | 1.203 | 0.442 | 3.398 | 0.442 | 0.637 | 0.152 | 0.342 | 0.003 |
| 82 | 6.319 | 0.291 | 0.673 | 2.144 | 1.189 | 0.156 | 0.314 | 1.491 | 0.592 | 4.101 | 0.592 | 0.821 | 0.197 | 0.429 | 0.009 |
| 83 | 5.903 | 0.276 | 0.637 | 1.995 | 1.120 | 0.136 | 0.290 | 1.391 | 0.560 | 3.829 | 0.560 | 0.760 | 0.189 | 0.418 | 0.004 |
| 84 | 5.845 | 0.250 | 0.599 | 2.037 | 1.102 | 0.136 | 0.285 | 1.378 | 0.508 | 3.880 | 0.508 | 0.734 | 0.176 | 0.391 | 0.006 |

| No. | Total | Europe | North America | South America | Southern Asia | Northern Asia | Oceania | Africa | Boreal Forest | Tropical Forest | Temperate Forest | Shrubland | Grassland | Cropland | Tundra |
|-----|-------|--------|---------------|---------------|---------------|---------------|---------|--------|---------------|-----------------|------------------|-----------|-----------|----------|--------|
| 85 | 6.217 | 0.300 | 0.683 | 2.075 | 1.162 | 0.158 | 0.309 | 1.469 | 0.622 | 3.986 | 0.662 | 0.827 | 0.195 | 0.408 | 0.010 |
| 86 | 6.938 | 0.312 | 0.729 | 2.371 | 1.307 | 0.173 | 0.346 | 1.633 | 0.627 | 4.525 | 0.627 | 0.894 | 0.215 | 0.471 | 0.013 |
| 87 | 5.874 | 0.276 | 0.631 | 1.981 | 1.093 | 0.154 | 0.294 | 1.387 | 0.572 | 3.785 | 0.572 | 0.779 | 0.180 | 0.377 | 0.012 |
| 88 | 5.571 | 0.276 | 0.619 | 1.847 | 1.043 | 0.138 | 0.277 | 1.318 | 0.573 | 3.556 | 0.573 | 0.743 | 0.177 | 0.372 | 0.006 |
| 89 | 5.908 | 0.260 | 0.608 | 2.040 | 1.099 | 0.153 | 0.294 | 1.396 | 0.531 | 3.875 | 0.531 | 0.764 | 0.175 | 0.375 | 0.013 |
| 90 | 6.759 | 0.304 | 0.708 | 2.307 | 1.259 | 0.181 | 0.339 | 1.595 | 0.619 | 4.394 | 0.619 | 0.885 | 0.204 | 0.433 | 0.018 |
| 91 | 6.084 | 0.306 | 0.685 | 2.002 | 1.141 | 0.151 | 0.303 | 1.438 | 0.637 | 3.862 | 0.637 | 0.816 | 0.197 | 0.411 | 0.007 |
| 92 | 5.669 | 0.279 | 0.626 | 1.880 | 1.058 | 0.148 | 0.285 | 1.339 | 0.579 | 3.608 | 0.579 | 0.763 | 0.178 | 0.372 | 0.011 |
| 93 | 6.102 | 0.278 | 0.644 | 2.080 | 1.139 | 0.157 | 0.304 | 1.440 | 0.570 | 3.967 | 0.570 | 0.797 | 0.185 | 0.396 | 0.012 |
| 94 | 6.085 | 0.281 | 0.646 | 2.065 | 1.136 | 0.157 | 0.304 | 1.436 | 0.576 | 3.939 | 0.576 | 0.800 | 0.186 | 0.397 | 0.012 |
| 95 | 8.086 | 0.378 | 0.872 | 2.716 | 1.519 | 0.214 | 0.408 | 1.899 | 0.760 | 5.194 | 0.760 | 1.067 | 0.256 | 0.547 | 0.021 |
| 96 | 7.247 | 0.342 | 0.784 | 2.429 | 1.354 | 0.195 | 0.365 | 1.707 | 0.700 | 4.648 | 0.700 | 0.964 | 0.226 | 0.474 | 0.018 |
| 97 | 7.495 | 0.344 | 0.797 | 2.537 | 1.406 | 0.197 | 0.377 | 1.764 | 0.695 | 4.845 | 0.695 | 0.982 | 0.234 | 0.500 | 0.018 |
| 98 | 7.284 | 0.365 | 0.822 | 2.389 | 1.358 | 0.196 | 0.367 | 1.716 | 0.760 | 4.597 | 0.760 | 0.992 | 0.233 | 0.476 | 0.016 |
| 99 | 6.607 | 0.341 | 0.756 | 2.148 | 1.232 | 0.175 | 0.333 | 1.557 | 0.714 | 4.141 | 0.714 | 0.908 | 0.214 | 0.436 | 0.012 |
| 100 | 7.233 | 0.334 | 0.775 | 2.446 | 1.351 | 0.190 | 0.361 | 1.705 | 0.683 | 4.678 | 0.683 | 0.951 | 0.223 | 0.469 | 0.016 |

Table S3 The estimated mean N₂O emissions and emission rates per unit area at continental- and biome-scale with the uncertainty ranges. kg N ha⁻¹ yr⁻¹ = 0.1 g N m⁻² yr⁻¹

| Continental-scale | Europe | North America | South America | Southern Asia | Northern Asia | Oceania | Africa |
|---------------------------------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------------|
| N ₂ O emissions (Tg N yr ⁻¹) | 0.29 (0.21~0.40) | 0.66 (0.51~0.89) | 2.09 (1.63~2.73) | 1.16 (0.90~1.52) | 0.16 (0.11~0.26) | 0.31 (0.23~0.52) | 1.46 (1.13~1.91) |
| N ₂ O emission rate (kg N ha ⁻¹) | 0.31 (0.23~0.43) | 0.31 (0.24~0.42) | 1.23 (0.96~1.61) | 0.52 (0.40~0.68) | 0.13 (0.09~0.22) | 0.41 (0.31~0.69) | 0.73 (0.56~0.95) |
| Biome-scale | Boreal Forest | Tropical Forest | Temperate Forest | Shrubland | Grassland | Cropland | Tundra |
| N ₂ O emissions (Tg N yr ⁻¹) | 0.17 (0.10~0.25) | 4.01 (3.12~5.21) | 0.59 (0.43~0.82) | 0.82 (0.61~1.08) | 0.20 (0.15~0.25) | 0.41 (0.32~0.55) | 0.01 (0.002~0.05) |
| N ₂ O emission rate (kg N ha ⁻¹) | 0.17 (0.11~0.26) | 1.60 (1.25~2.09) | 0.37 (0.27~0.51) | 0.34 (0.26~0.45) | 0.2 (0.15~0.26) | 0.46 (0.36~0.61) | – |

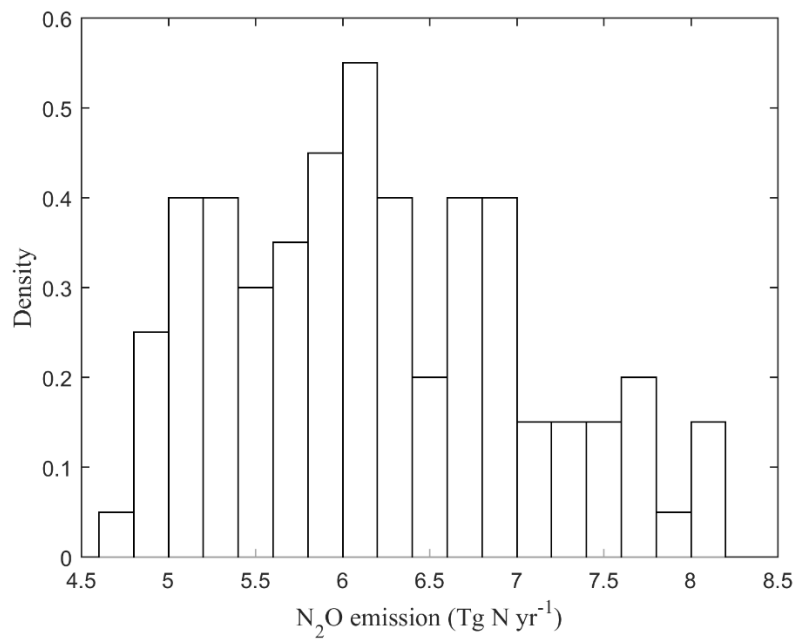


Fig. S1. The distribution of 100 sets of results from DLEM simulations.

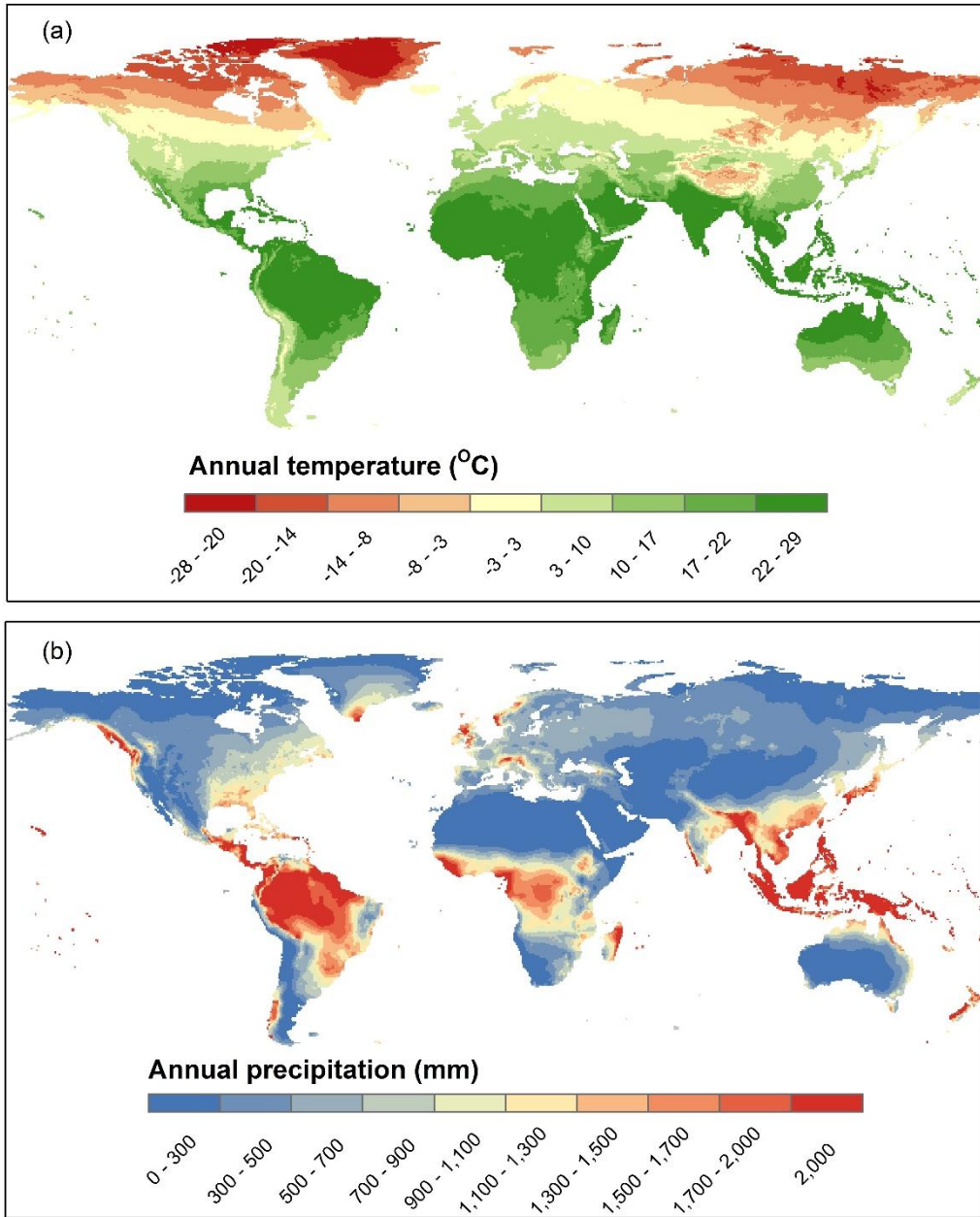


Fig. S2. (a) The average annual temperature during 1901–1930; (b) The average annual precipitation during 1901–1930.

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